ENGINEERING CASE LIBRARY

ECL 187A

VALUE ENGINEERING APPLIED TO AN IBM LEVELING SCREW (A)

This case provides a brief look at the methodology of Value Engineering. A leveling screw for the IBM 1311 disk storage drive was assigned to students in an IBM Value Engineering Seminar. The students applied their newly learned techniques to redesign the leveling screw to reduce cost while maintaining function. Their solution was so successful that it was put into production on many IBM systems resulting in over one million dollars in savings.

 Prepared by Prof. R. Piziali with support by the San Jose Division of IBM Corporation. Assistance by W. Goddard, M. Johnson, J. Minick, G. Pastre, and L. Sheldon is gratefully acknowledged.

VALUE ENGINEERING APPLIED TO AN IBM LEVELING SCREW (A)

It was at the very first Value Engineering seminar and on project #1 that Charles Hallstrom and Ken Ravizza produced a classic example of what can be accomplished by Value Engineering. Their project was to apply value technology to leveling screw systems used on the 400 lb. 1311 disk storage drive. The leveling system (Exhibit A-2) consisted of four 5/8" by 6" acme screws with friction plugs which screw into nuts welded to the 1311 frame. The field engineer was to raise the 1311 on the leveling screws, remove the casters, and then lower the machine so that the leveling screws averaged about 1 1/2" below the frame. Acme threads were used because their large lead angle minimized the time required for this operation. The San Jose plant was purchasing these screws and nuts from IBM's Endicott facility at a cost of $12.50 per screw-nut assembly.

The first thing that struck Ken Ravizza was that the present leveling assembly was overpriced. He checked past records and found that there had been a bookkeeping error and San Jose was paying the model price rather than the production price. This resulted in an instant cost reduction to $4.44 per assembly ($2.62 per screw and $1.82 per nut). With this as their starting point, Ravizza and Hallstrom applied their newly acquired Value engineering technology to the leveling screw design.

Although many definitions exist for Value Engineering, L. E. (Ed) Sheldon and M. A. (Bert) Johnson refer to it as "an organized discipline for achieving the lowest cost without sacrificing the standards of quality, performance, reliability and appearance." It is this concept that IBM's Value Engineering course tries to establish as part of their students'

approach to problem solving. Value engineering technology should blend with other technologies to become part of all engineering design. In fact the basic steps of value engineering are similar to those of design or problem solving with the concept of cost interacting with those of function and quality. They are

1. <u>Identify the Function</u>
    a. What is it?
    b. What is required?
    c. What does it do?
    d. What should it do?

2. <u>Evaluate the Function</u>
    a. What should it cost?
    b. What does it cost?

3. <u>Develop Value Alternatives</u>
    a. What else will do the job?
    b. What will these cost?

4. <u>Determine Best Value Alternatives</u>
    a. Which one provides the desired requirements at the lowest cost?

5. <u>Implement Best Value Alternatives</u>

6. <u>Follow Through to Completion</u>

An expanded outline along with further value engineering concepts are presented in Exhibit A-2.

Value Engineering as it is presently practiced started at the General Electric Company in 1946 under the direction of Lawrence D. Miles.[1] Miles is reputed to have walked into his boss's office and asked, "Doesn't anybody here care about what things cost." From that statement, Miles and a small group of General Electric engineers developed the methodology of Value Engineering which has resulted in an estimated $200 million savings in its first 17 years at General Electric. Considerably more money has been saved throughout private industry and in the Department of Defense through the utilization of Value Engineering. In one of his early Value Engineering jobs, Mr. Miles reduced the cost of a quantity part used in General Electric's Telechron Clock Motor from 1/3¢ to 1/5¢. This cost reduction of .13¢/part resulted in an annual savings of $112,000. His methods have resulted in considerable savings for the Armed Forces and Miles was awarded the Navy's Distinguished Public Service Award for his work in developing an office of Value Engineering in the Navy's Bureau of Ships.

IBM's San Jose plant began utilizing Value Engineering in 1957 and in 1963 Value Analysis, Inc., a private consulting firm, presented the first Value Engineering Seminar at the San Jose site. Since that time, IBM's Education Department has presented forty-four Value Engineering Seminars under the direction of Bert Johnson and Ed Sheldon. These courses present the concepts and techniques of Value Engineering and then have the students apply their newly learned technology to selected problems. The problems are selected from existing IBM components or

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[1] See <u>Techniques of Value Analysis and Engineering</u> by Lawrence D. Miles, McGraw-Hill.

practices and over the years, over 300 cases document possible savings which average 37%. These cases also verify Miles findings that even small cost reductions are important on high production components.

SESSION E-2

VALUE ENGINEERING - A WORKING TOOL OF INDUSTRY*

ECL -187A

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ABSTRACT

Six basic steps are presented as an effective, organized approach to value engineering. These steps are directly applicable to hardware design, procurement, and manufacture, and may be used in other facets of business endeavor, including processes and procedures. This proven approach achieves lowest cost by identifying and evaluating the functional product requirements, and satisfying these requirements through a selection of suitable value alternatives.

INTRODUCTION

No small number of directors have seen their companies fold because, for one reason or another, they have been unable to compete with others in their field. Some of these companies might be in business today if they had been aware of, and used, a valuable working tool of industry: value engineering.

What is value engineering? It is simply this: an organized approach for achieving the lowest cost, without sacrificing the standards of quality, performance, reliability, and observable appearance. This combination makes a product enviably competitive. Because value engineering is easily applied, countless companies, as well as all of our armed services, have benefited from the philosophy since it was introduced by Mr. Lawrence D. Miles shortly after the close of World War II. Their combined savings have run into millions of dollars.

When value engineering is applied in depth and followed diligently, it involves doing the job in the best possible way. This does not imply that other disciplines no longer have a place. Value engineering is general in nature and furnishes the framework into which other disciplines which have proven advantageous can be fitted. Furthermore, it provides tested techniques which keep the users on course, and for the first time puts requirements in terms of function and then determines the value of the function.

Before proceeding to describe the working intricacies of value engineering, let us consider the results one can expect from its use. If it is applied to a product, one can expect to get a quality, low-cost product that will perform as intended, be reliable, and have the required aesthetic value to give it customer appeal. If it is applied to a process or service, one can expect quality and low-cost results with no degradation in the end product of the process or in the service rendered. The final outcome should be (1) more sales or business, (2) higher wages for employees, (3) greater returns to the stockholders, and (4) more congenial business relations.

VALUE ENGINEERING - THE DISCIPLINE

What gives value engineering its organized approach? In our case it is an outline which we have chosen to call "The Six Basic Steps" (see Figure 1a-f). In his book on the subject,[1] Mr. Miles introduces the basic steps and gives three. We have taken these three and have added three more to complete the outline. The "Six Basic Steps" are:

Identify the Function (Figure 1a)

In this step you gather all possible information pertaining to the particular item, process, or service you are starting to value engineer. You ask yourself the questions: (a) "What is it?" and (b) "What does it do?" Or, if it is not yet in existence, (a) "What is required?" and (b) "What should it do?" Before going on to Basic Step #2, stop here and summarize "identify the function" by generating two-word descriptors, made up of a verb and a noun, which describe the functions of the item. These are in turn classified as either primary functions or secondary functions. As an example, let us assume you are designing a tie clasp. The primary functions would then be secure tie and enhance appearance.

Evaluate the Function (Figure 1b)

In this step you put a dollar value on the combined functions arrived at in Basic Step #1. You ask yourself, "What should it cost?" (i.e., what is its functional value?). Functional value is the lowest cost at which you feel you can obtain something to satisfy the primary function or functions and the necessary secondary functions reliably. It is determined hypothetically, based on your own knowledge and past experience. It is the target for which you shoot.

If a solution to the function presently exists, you can ask yourself, "What does it cost?" If investigation shows that the answer to this question is close to what you felt was the lowest cost for obtaining the function or functions, you already have good value and should proceed to investigate the next item, starting with Basic Step #1.

Develop Value Alternatives (Figure 1c)

You are now ready to come up with other methods of satisfying the function or functions. You ask yourself, "What alternatives will do the job?" and "What will these cost?" This is where you become creative and really make your effort pay off. From Basic Step #1, you know what you want, and Basic Step #2 has given you the cost target for which you will be shooting. Of course, you will be trying to obtain the function or functions at even a lower cost.

Creative problem solving is a subject in itself and, if mastered, could be profitably applied at this point. Possible approaches include utilization of checklists, multidimensional arrays (see Figure 2), and brainstorming.

Determine Best Value Alternative (Figure 1d)

In this step the most promising solutions of Basic Step #3 are taken and evaluated further. Detailed information and costs are obtained. Cost estimators, purchasing, vendors, and specialists are called upon as required. When you complete this step, you have all the information necessary at hand to confidently answer the question, "Which one provides the desired requirements at the lowest cost?"

Implement Best Value Alternative (Figure 1e)

To stop after Basic Step #4 would probably mean that, although most of the work has been done, no results will be forthcoming. The individual who has done the work thus far and who has the greatest confidence that a good value-engineered solution has been arrived at should be the one to see that his solution is implemented.

Follow Through to Completion (Figure 1f)

Even after implementing, which often means getting the engineering change out, writing a letter, or ordering parts, many good solutions can be sidetracked or overlooked. Each job should be checked up on periodically until finally completed. Only in this way can one be sure that maximum value is realized.

*This paper describes the basic steps presented by the authors in the Value Engineering Seminar (Session E2).

EXHIBIT A-1

Some concepts of value engineering.

General Concepts of Value Engineering

1. $$\text{Value} = \frac{\text{Performance} + \text{Appearance (Esteem)}}{\text{Cost to Buy}}$$

   Good value is relative to the state of the art. What is exceptional value today may be marginal value in one year because of technology, material, or process evolution.

2. A comparison between the Value Engineering approach and routine Cost Reduction activity is given below:

Cost Reduction	Value Engineering
Emphasis on part	Emphasis on function
Sporadic activity	Continuous activity
Committee action	Formal organization
Experience and judgement	Systematic approach
Accounting oriented costs	Oriented to economic value
Responds to need	Planned initiation

Value Principles for Designers

It is widely understood that the fundamentals of VE are general in nature and can be applied to all phases of business as well as to personal endeavors. Also, VE provides an excellent framework into which other design disciplines can be fitted. Seemingly, one could not ask for a more ideal situation. However, in order that VE can be focused directly upon design and the full dynamic impact felt, certain principles are needed by designers. These principles are:

1. Challenge all requirements and specifications.
2. Satisfy functions with simpler designs.
3. Employ standardization whenever economically justified.
4. Avoid re-inventing available specialty items.

5. Design for ease of manufacturing.
6. Utilize lowest cost appropriate material.
7. Specify suitable inexpensive surface finishes.
8. Purchase lower cost commercial items.
9. Select custom suppliers for best values.
10. Design for optimum tool and best processes.

EXHIBIT A-1

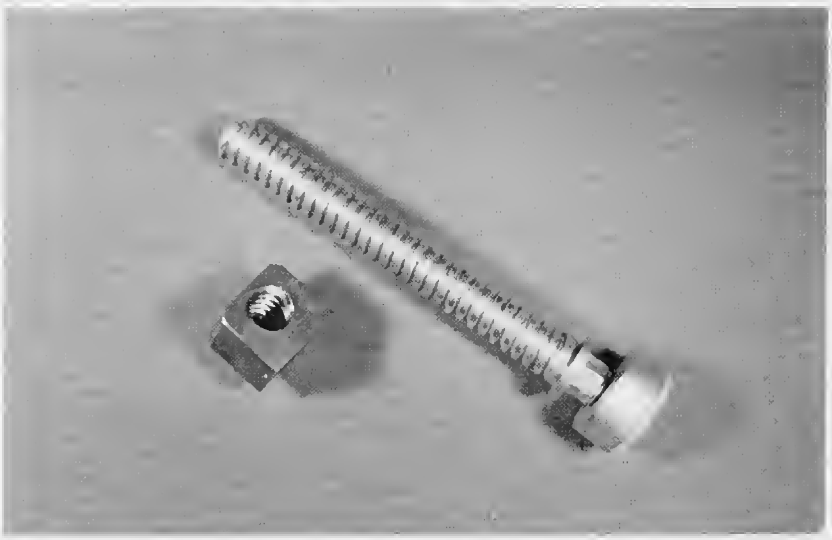


EXHIBIT A-2

Acme leveling screw and nut.

ECL 187B

ENGINEERING CASE LIBRARY

VALUE ENGINEERING APPLIED TO AN IBM LEVELING SCREW (B)

VALUE ENGINEERING APPLIED TO AN IBM LEVELING SCREW (B)

After learning the methodology of Value Engineering, Charles Hallstrom and Ken Ravizza progressed quickly and easily through their leveling screw redesign. Their first step was to identify the function of their component. In the case of the 1311 leveling screw, their two-word descriptor was "level machine." They then had to evaluate the function. Considering that the 1311 weighed about 400 lbs. and that it would be leveled only a few times in its lifetime, a couple of dollars seemed to be a reasonable price for this function. However, with four leveling screws per machine, IBM was now paying $17.76 for the leveling function. This large discrepancy in value vs. cost indicated that alternative solutions should be investigated.

The present design allowed the head of the screw to swivel to match irregular surfaces and with six threads per inch it was quick to adjust.

The first alternative investigated was a carriage bolt and nut. A 1/2 - 13 bolt was selected primarily because it was a standard shelf item; however, it would result in slower leveling than the six threads per inch of the acme screw. Ken and Charles felt that this change could be tolerated by the field engineer. The lower lead angle of the screw and a lock nut was sufficient to prevent slippage and a snap-on nylon cap would be added to the screw to allow low friction between the screw and the floor during adjustment. After checking with manufacturers they found that their design could be supplied for 56.5¢ for each screw and nut assembly. They considered tapping the frame but felt that the labor

cost in the tapping would exceed the cost of a nut and welding. Ken and Charles were convinced this would be the lowest cost functional alternative and decided against further investigation. They presented their Value Engineering project (Exhibit B-1) and recommended that it be immediately implemented to the remaining 1311 machines at a very large total savings. Because they were in a classroom situation, Ken and Charles were only able to progress through the first four steps of VE. However, the potential savings of their redesign encouraged IBM management to assign Bert Johnson to follow up on the concept and to have it implemented.

Bert discovered that carriage bolts with cold upset heads were commercially available. This bolt had a square section immediately below the head (Exhibit B-2), which facilitated using a wrench. For a small additional cost the head diameter could be made to meet Berts +.01,-.000 tolerance and he designed a snap-on nylon cap to interface the screw with the floor. Bert had a nylon cap machined to test his concept. His primary problem was getting the cap onto the head. It would not push on and he was afraid a hammer would cause a peak shock load which could break the nylon. Therefore, he set up a quick press fixture constructed primarily of 2 x 4's and pressed the cap onto the bolt.

In evaluating this design with Joe Sheredy, the Program Manager of the 1311, it came to light that, because of the number of revolutions needed to level the machine, it was unacceptable. Bert decided to ask the bolt manufacturers about the possibility of getting double-lead threads on the bolts, which would give him an effective 6 1/2 threads per inch. When the manufacturer stated that double-lead threads could

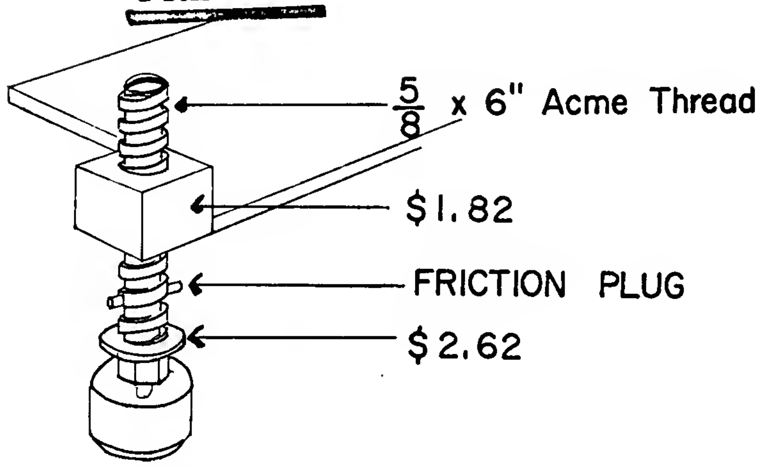
be supplied at no additional cost, the change was made. Bert then contacted a plastics manufacturer to cast the caps (Exhibit B-3). The new cap had a curved bottom surface to help the leveling screw conform to irregular surfaces and it snapped easily onto the bolt. When parts to the new design were obtained, Joe Sheredy had machines fitted and thoroughly tested. The new design leveled the machine properly, and no slippage occurred. Having been accepted, they were released as an Engineering Change for use on all future 1311's.

It is interesting to note that further Value engineering was performed on the leveling screws when they were being redesigned for use with the 2314. The function of the screw length on the 1311 was to allow the machine to be raised for removal of its casters and then lowered to its level position. However, on the 2314 it was only necessary to raise the machine sufficiently to remove the weight from the casters. With this function removed, the leveling screws were shortened realizing another cost reduction.

This design was not only used on the 1311 and 2314 but on many other components throughout IBM's international organization. Their usage over the years has resulted in well over a million dollars in savings. With a start like this, it is no wonder that Value Engineering is at IBM to stay.

GLIDE ASSEMBLY

PRESENT

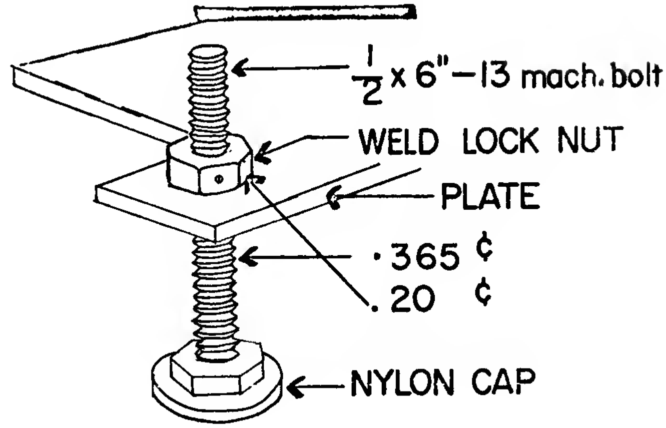


COST ANALYSIS

PRESENT COST	\$4.44 ea.
PROP. COST	\$ .565 ea.
SAVINGS	\$3.875 ea

FIRST YEAR'S PROPOSED
SAVINGS \$91,000

PROPOSED



87.5 % REDUCTION

VE #1

EXHIBIT B-1

Value engineering report on leveling screw problem.

FORM 920-7648-2

REQUEST FOR ENGINEERING CHANGE

FOR ORIGINATING DEPT.	MACH. TYPE	PROJ. NO.	MFG. ENG. ACT. CODE
Value Engr Team I	1311		

SUGGESTION NO.

SERVICE REQUEST

REQUESTED BY P. J. Ravizza C Hallstrom DEPT. NO. DATE 4/8/63

DEPT. NO. PLANT NO. APPROVED BY DATE

APPROVED ESTIMATED HOURS			
MGR	STAFF	DATE	HOURS
ORIGINAL ESTIMATE			
ADDITIONAL HOURS			

FOR PRODUCT ENGINEERING DEPT.

M/S	DEPT. NO.	ENG. TYPE	PROJ. NO.	MACH. TYPE	REQ. NO.

M. / (REC'D) / Y. | CONTROL CARD INFORMATION | ENG. INIT. | EST. HRS. | M. / (DESIGN) / Y.

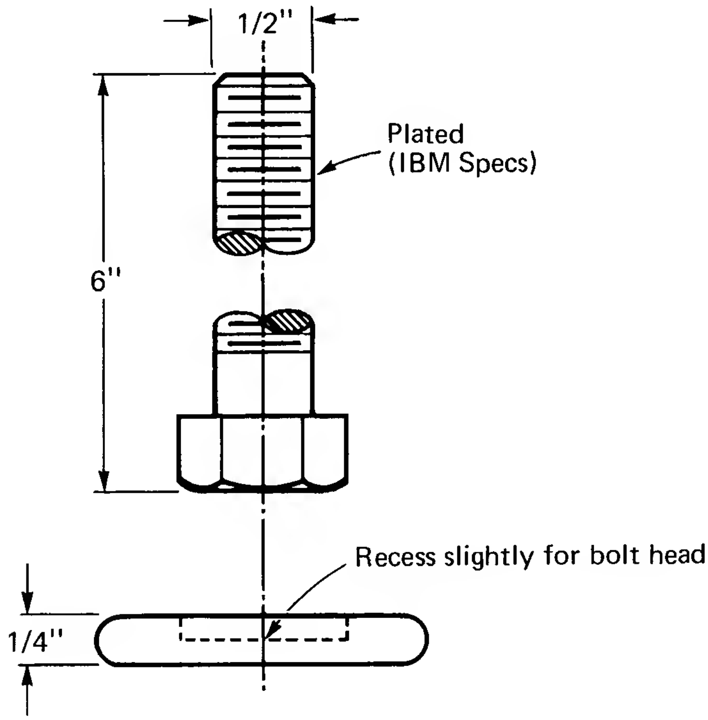
PART NO.	PART NAME: Glide Asm MACHINE TYPE: 1311 (All Models)
749895	REQUESTED CHANGE, REASONS AND ECONOMIC JUSTIFICATIONS: Delete Part # 749895 - In its place use one Plated Machine Bolt 1/2 x 6"-13 completely threaded and glue a molded plastic cup to Bolt head (See attached sketch) Usage 4 per machine Usage 1st yr 24,000 - Present Cost per unit $2.62 New Cost .365 ea - Estimated 1st yrs savings: ~~$~~ $54,120
2154024	FRAME ASM - Change reinforcing plate used on the four corners of the frame to accommodate a pilot weld nut (see attached sheet) in place of 1" steel bar which is drilled and tapped to .625-6
	INVESTIGATOR'S REPORT: to accommodate glide asm. Usage 4 per frame - Usage 1st yr 24,000 - Present Cost $1.82 New Cost .20 ea - Estimated 1st yr Savings $36,880
	TOTAL SAVINGS FROM CHANGE FOR 1ST YEAR $91,000

EXHIBIT B-1

SCREW JACK
Engineering Change Drawing

Nut :	See attached sheet for drawing
Type :	Projection weld nut (MF Company) with pilot and two-way self locking feature
Size :	1/2" - 13
Material :	Low carbon steel
Mfg. Part No:	2369

Bolt:



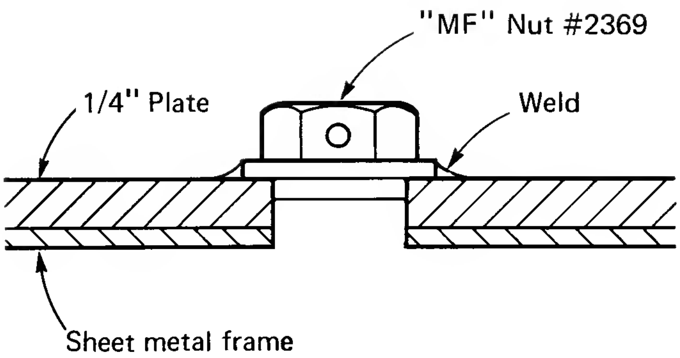
Type:	Machine bolt
Size:	1/2" - 13 x 6"
Material:	Steel

Glide cap:

Type :	Plastic cap
Material :	Nylon
Size :	1/4" larger diameter than bolt head 1/4" thick
Fastening :	Epoxy or similar material

EXHIBIT B-1

Bolt Fastener



Bolt Fastener - Alternate

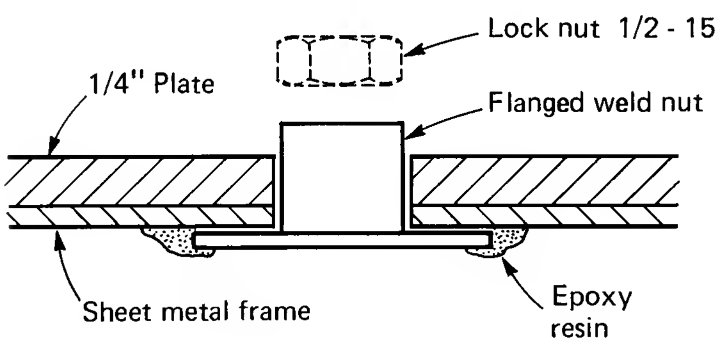
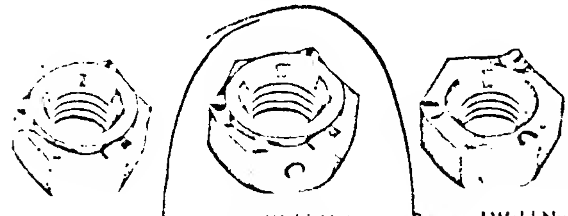


EXHIBIT B-1

PROJECTION WELD NUTS



Pilot Weld Nut — Pilot Weld Nut with Two-Way Locking Feature — Recessed Weld Nut

All weld nuts are available with MF Two-Way locking feature if desired. Weld nuts to special shapes and dimensions upon request.

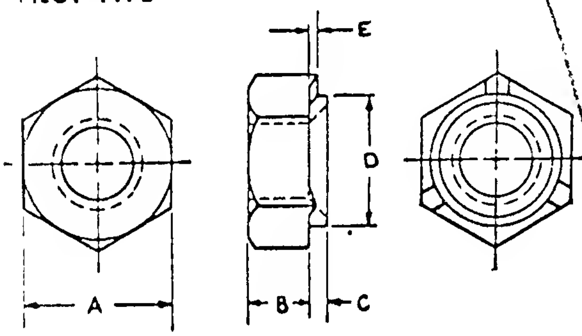
MF Projection Weld Nuts are engineered for simplification of assembly of many products. Welding of nuts to various sub-assemblies permits using screws or bolts in the main assembly without need for holding nuts from turning (often eliminating the extra time and labor required to hold the nut or bolt from turning). Also, design can be completely changed by locating weld nuts where it would be impossible to use other nuts.

PILOT TYPE Projection Weld Nuts have a pilot that automatically locates them in holes punched in the sub-assembly, eliminating any need for jigs, special locating fixtures or measurements. Pilot also forms a positive barrier between weld and threads, preventing any weld spatter in the threads. Special pilots available on request.

RECESSED TYPE Weld Nuts have a recess around the hole to eliminate clogging the nut threads by weld flow or spatter—no retapping needed—no delays or annoyances on assembly line.

SIZES and DIMENSIONS

PILOT TYPE



Material: Low carbon steel.

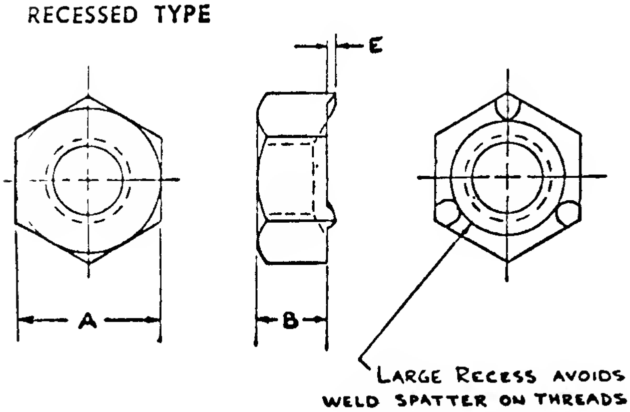
Dimensions: Dimensions in accompanying table are full thickness (for full strength) of standard nuts.

Threads: Unified coarse or fine threads Class 2B (See A.S.A. B1.1 1949) in stock. Special threads available.

Ordnance: For pilot, type shown on Ordnance Print BBNX5. For recessed, type shown on Ordnance Print BBNX4.1.

Two-Way Locking: This MF feature is available for each type Weld Nut.

RECESSED TYPE



Nut Size	M-F Dw'g. or Part No. Without Lock	With Lock	A	B ±.010	C ±.005	D +.000 −.012	E ±.003	Dia. of Hole in Plate for Locating Pilot	Wt. per M	Container Quantities
LONG PILOT* • for material 13 gauge and thicker										
#8-32	2346	2347	1/2	3/16	.085	.406	.040	27/64	10.5	15,000
#10-24	2348	2349	1/2	3/16	.085	.406	.040	27/64	10.5	15,000
32	2350	2351	1/2	3/16	.085	.406	.040	27/64	10.5	15,000
1/4-20	2352	2353	1/2	3/16	.085	.406	.040	27/64	10.2	15,000
28	2354	2355	1/2	3/16	.085	.406	.040	27/64	10.2	15,000
5/16-18	2356	2357	9/16	7/32	.085	.469	.040	31/64	13.7	12,000
24	2358	2359	9/16	7/32	.085	.469	.040	31/64	13.7	12,000
3/8-16	2360	2361	5/8	1/4	.085	.531	.040	35/64	18.5	8,000
24	2362	2363	5/8	1/4	.085	.531	.040	35/64	18.5	8,000
7/16-14	2364	2365	3/4	5/16	.085	.656	.040	43/64	33.0	4,500
20	2366	2367	3/4	5/16	.085	.656	.040	43/64	33.0	4,500
1/2-13	2368	2369	13/16	3/8	.085	.719	.040	47/64	45.0	4,000
20	2370	2371	13/16	3/8	.085	.719	.040	47/64	45.0	4,000
SHORT PILOT* • for material 14 gauge and thinner										
8-32	2320	2321	1/2	3/16	.040	.406	.025	27/64	10.5	15,000
#10-24	2322	2323	1/2	3/16	.040	.406	.025	27/64	10.5	15,000
32	2324	2325	1/2	3/16	.040	.406	.025	27/64	10.5	15,000
1/4-20	2326	2327	1/2	3/16	.040	.406	.025	27/64	10.2	15,000
28	2328	2329	1/2	3/16	.040	.406	.025	27/64	10.2	15,000
5/16-18	2330	2331	9/16	7/32	.040	.469	.025	31/64	13.7	12,000
24	2332	2333	9/16	7/32	.040	.469	.025	31/64	13.7	12,000
3/8-16	2334	2335	5/8	1/4	.050	.531	.030	35/64	18.5	8,000
24	2336	2337	5/8	1/4	.050	.531	.030	35/64	18.5	8,000
7/16-14	2338	2339	3/4	5/16	.050	.656	.030	43/64	33.0	4,500
20	2340	2341	3/4	5/16	.050	.656	.030	43/64	33.0	4,500
1/2-13	2342	2343	13/16	3/8	.060	.719	.035	47/64	45.0	4,000
20	2344	2345	13/16	3/8	.060	.719	.035	47/64	45.0	4,000
RECESSED TYPE										
#8-32	2374	2375	7/16	3/16			.040		7.2	20,000
#10-24	2376	2377	7/16	3/16			.040		7.0	20,000
32	2378	2379	7/16	3/16			.040		7.0	20,000
1/4-20	2380	2381	7/16	3/16			.040		6.0	20,000
28	2382	2383	7/16	3/16			.040		6.0	20,000
5/16-18	2384	2385	5/8	9/32			.040		20.0	8,000
24	2386	2387	5/8	9/32			.040		20.0	8,000
3/8-16	2388	2389	3/4	5/16			.040		32.5	5,000
24	2390	2391	3/4	5/16			.040		32.5	5,000
7/16-14	2392	2393	13/16	3/8			.040		45.0	4,000
20	2394	2395	13/16	3/8			.040		45.0	4,000
1/2-13	2396	2397	7/8	7/16			.040		57.6	3,000
20	2398	2399	7/8	7/16			.040		57.6	3,000

*Also available in Miniature Series up to ¼ in. nut size.

EXHIBIT B-1

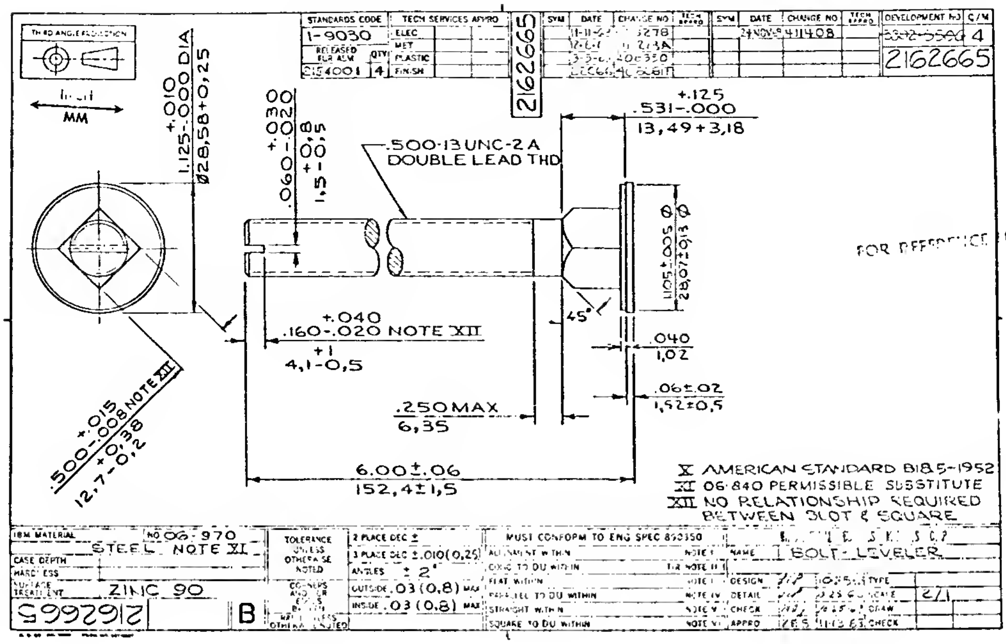


EXHIBIT B-2

Carriage bolt drawing.

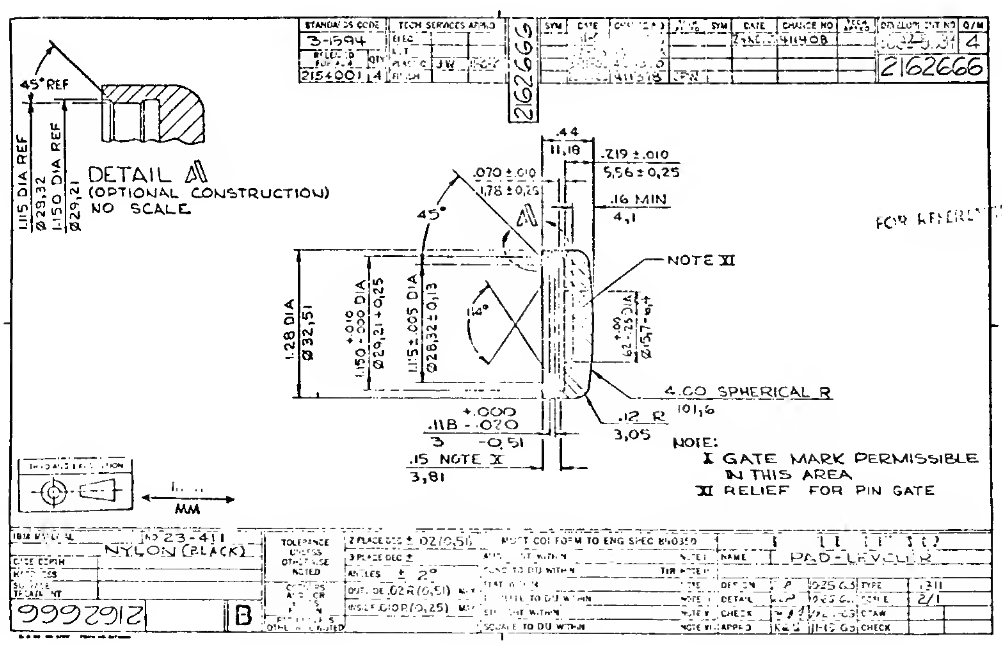


EXHIBIT B-3

Plastic cap drawing.